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Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,337,284** on February 15, 2001, by **TERASPAN NETWORKS INC.**, assignee of Darren Dofher, for "Surface Fibre Optic Cable Network Installation".

Tracy Faulkner
Agent certificateur/Certifying Officer

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ABSTRACT

A method of installing fibre optic cables consists of cutting a shallow and narrow trench or channel within a road surface or building wall. A narrow fibre optic cable is laid within the channel, and subsequently covered with a patch material. A branching cable network is provided by cutting at periodic and selected locations, a slightly broader and deeper region of the channel, within which cable loops and/or junction boxes are installed. The nodes may consist of branching nodes, or alternatively non-branching nodes containing a cable loop and/or junction box, the installation of which at a location permits a junction node to be formed at a close by location. The invention also consists of a junction box for use with the system.

SUBSURFACE FIBRE OPTIC CABLE NETWORK INSTALLATION

Field of the Invention

The present invention relates to subsurface installation of fibre optic cables, for example, in urban settings where cable is laid under in streets or sidewalks. As well, the invention relates to installation within masonry construction and other construction, as well as systems for forming a branching fibre optic cable network.

Background of the Invention

With the rapidly growing need for high-speed data connections to businesses and residences (driven mainly by the need to access the Internet) a faster and more economical method is needed in order to deliver these connections. Optical fibre offers the greatest potential to deliver high-speed services due to its ability to carry extremely high bandwidth over very long distances. The one problem that the telecommunications industry has been faced with is the high cost of installing optical fibre between the provider and the end customer. This issue has restricted the expansion of optical networks to very densely populated regions where the economics can justify the expensive traditional construction process.

It is contemplated that an inexpensive and simple means to lay cable is within a shallow slit-like trench cut into an upper layer of pavement or the like, for the laying of a cable within or immediately under a street or other surface. Such a system requires a convenient manner to form junctions or branches within the cable system. In conventional cable-laying systems or methods, the forming of a branching network requires considerable additional excavation in order to install conventional junction boxes or the like.

It is desirable to provide a system for installing a branching-type network of fibre optic cables which may be conveniently installed by means of cutting narrow slit-like trenches or recesses, for example, into street surfaces or

within building or residential walls. Such an arrangement should also provide a convenient means for subsequent location of intersection points, as well as providing for future expansion of the cable network. For the latter, it is important that this system provide an easy means to provide cable slack without requiring the labour-intensive job of splicing of cables to meet future system needs.

Further, it is desirable to provide a junction box or branching node which readily fits within a narrow slit like trench or groove without requiring substantial additional excavation, and which further is easy to install and subsequently locate.

Description of the Prior Art

Several patents have been issued for technology relating to electrical and optical fibre cable installations.

One example is U.S. Patent No. 5,879,109 issued to Finzel, Diermeir, Dotzer and Mayr which provides a complex process for introducing optical or electrical cable into solid grounds such as asphalt. The method uses a slow moving apparatus to heat the ground surface until it has softened. A channel-forming unit is subsequently used to introduce a channel into the heated ground by displacing the ground material alongside the channel border. A laying unit is then used to introduce the optical or electrical cable into the channel, followed by a filling unit which is used to reintroduce the displaced ground material back into the channel and then rolled to compact the ground material which has been reintroduced into the channel. However, the complexity of this method if used for small segment connections between end customers and providers of optical fibre cable within confined urban locations and in a variety of infrastructure materials would be prohibitively expensive. Also, this method does not work in concrete material as found in sidewalks, curbs and groutlines, which are often preferred routes in most last mile deployments.

In another example, U.S. Patent No. 6,065,902 issued to Mayr, Opel, Stocklein, Uhlenhuth and Finzel provides a method and apparatus for on-site production and installation of optical fibre cable at the location for placing. This method seeks tor educe transportation costs and quantity of material required for large-scale optical fibre cable installations. However, for small-scale installations this method is impractical and notably more expensive.

Canadian published application no. 2,237,324 (Zeidler et al) discloses a method for laying a thin fibre optic cable of between 2mm and 10mm, within a narrow channel having a width slightly wider than the cable. The cable is introduced into the channel by means of a cable feed device, and is filled with infill material by a filling device which moves along in a coordinated fashion with the laying device. The laying channel extends into the top several layers of a paved surface and is between 4cm and 15cm in depth, with 7 centimeters being touted as ideal.

Summary of the Invention

In accordance with the above objects, the present invention comprises in one broad aspect a method for laying or installing of a system comprising a branching network of fibre optic cables within a substrate such as a paved roadway, a masonry wall or other hard surface. The term "substrate" herein means any hard surface, whether a roadway, walkway, wall or the like. It is contemplated that system "nodes" are provided at intervals within the cable network system. A node may comprise a cable junction or a region of looped cable which may be used to provide cable slack for future node or junction installation. In this aspect, the method consists of the steps of:

a) cutting a narrow channel or groove within a surface such as pavement or other ground surface or a portion of a building or residential unit, the channel or groove having a width of between 2mm and 12mm and a depth of between 12mm and 172mm;

b) installing a fibre optic cable within the narrow channel;

c) providing at periodic convenient locations one or more system nodes by placing at such location a loop of cable, and a junction box, and connecting to said junction box on the first side thereof, inlet cable and on a second side of a junction box, two or more outlet cables;

d) forming an intersection at the node by means of providing two outlet cables at the node; and

e) backfilling and sealing said channel or groove.

The upper end of the depth range of the channel is preferably for crossing streets that may get resurfaced in order to survive a pavement grind and overlay. As well, a deeper cut is desirable if the surface is breaking away or is in generally bad shape. If the surface is sound then the cut is about 25mm deep. The blade that is used on the slab saw makes a cut that is 4.5mm wide.

The junction box consists of a narrow housing having a width suitable for fitting within the narrow channel.

The cable is preferably installed as one long continuous cable. Installation of a junction box requires that only the outer case of the cable is cut away and the optical fibres inside remain uncut and continuous. About 20 to 40 cm of the casing is stripped at the site of the junction box thus exposing the optical fibres which then get looped inside the junction box. The ends of the casing get clamped into the junction box so that the loops of exposed fibre can be spliced and worked without being strained by the springy cable casing. A passive optical component may be spliced into a passing fibre or the fibre from the primary cable could be broken and spliced onto a fibre from a cable that goes in a different direction.)

In another aspect a metal member capable of detection by a metal locating device is incorporated within the junction box or positioned over the junction box, in order to provide a convenient means for subsequent location of the junction box or node by means of a metal detection device.

In a further aspect, the channel as described above is formed within the interstices between pavers on a walkway or roadway, or within a masonry wall. In the case of a wall, the channel has a generally horizontal orientation and is formed between adjacent brick layers. In this aspect, the channel has the width described above but the shallower end of the depth range is sufficient, i.e. about 12mm deep. The channel is then covered with mortar grouting to provide a matching appearance with the remainder of the brick or masonry wall. In a similar fashion, the channel may be formed in the interstices within a brick or stone walkway or roadway.

In a further aspect, the location of the channels within a masonry wall may be indicated by visual indicators and/or metal implants for location by a metal detection device.

In a further aspect, the channel is wholly within a surface region or layer of an asphalt or concrete roadway or sidewalk. In a further aspect, the trench may be cut at or immediately adjacent to the junction of a roadway and a curb, or within an expansion joint between a curb and an adjacent sidewalk.

In a further aspect, a plurality of cables may be laid in overlying relationship within a trench.

In a further aspect, the trench may be filled with liquid resin or other anchoring cement to form a smoothly-finished patch. An example is a two part polyurethane grout that hardens, but remains flexible. When hardened, this material is very difficult to pick away and seals the cut. In a still further aspect, a wire may be positioned to immediately overly the installed cables to provide

a convenient means for removing the overlying patch material for future maintenance. In a still further aspect, a looped portion of fibre optic cable may be formed within a deepened portion of the channel at a location removed from the junction node to provide cable slack for future expansion of the cable network.

In a still further aspect, the invention relates to a junction box for installation within a narrow slit-like channel or trench, as part of a fibre optic branching network or system. In this aspect, the box consists of housing or case having flat opposing sides with an overall width of about 10mm apart to fit within a narrow slit-like trench or channel. The inside cavity is about 6mm in width to accommodate passive optical components and/or splices. The two sides are joined together by releasable fastening means. Conveniently, the box is generally rectangular in all elevations. An opening at one of the ends of the box permits entry of input cable line. A plurality of openings on a second, opposed end of the box permits the outlet of output cable lines. The inlet and outlet entries are provided on the narrow ends of the box in order to maintain a flat, narrow arrangement when the cables are joined with the box. Sufficient space within the junction boxes provided for joining together the input and output cable ends. As well, passive optical networking components and optical splices may be placed in the box.

In a still further aspect of the above method, one or more loops of cable slack are formed to surround the junction box prior to burial of the node.

The term "approximately" or like terms herein mean plus or minus 10 per cent.

Brief Description of the Drawings

Figure 1 is a sectional view of a typical fibre optic cable for use in accordance with the present invention;

Figure 2(a) is a side elevational view showing a subsurface installation

according to the present invention, including a junction box;

Figure 2(b) is a plan view of an installed subsurface system;

Figure 3 is a similar view as in figure 2(a), showing a looped cable arrangement in a subsurface installation;

Figure 4 is a similar view, showing cable loops prior to burial;

Figure 5A is showing a plan view of the channel;

Figure 5B is showing a side elevational view of a channel with a junction box installed therein;

Figure 6 is a side view of a masonry brick wall with a cable installed within a horizontal channel;

Figure 7 is a close up view of Figure 6 showing a cable installed within a narrow channel between brick layers;

Figure 7a is a view similar to that of Figure 7 showing an alternate form;

Figure 8 is a sectional view, showing a trench cut within an asphalt or concrete roadway or sidewalk, with a plurality of cables buried within the channel;

Figure 9 is a similar view, showing a channel recessed into an expansion joint between a curb and sidewalk;

Figure 10 is a similar view, showing a close up view of multiple cables installed within a trench cut into asphalt or concrete;

Figure 11 is a cross-sectional view showing an alternative installation within a concrete or asphalt roadway or surface;

Figure 12 is a more detailed view of the installation shown in Figure 11;

Figure 13 is a plan view showing the lid portion of a junction box according to the present invention;

Figure 14 is a plan view showing a base portion thereof;

Figure 15(a) is a front elevational view of a further embodiment of the invention; and

Figure 15(b) is a side elevation of the version of Figure 15(a).

Detailed Description of the Preferred Embodiments

Turning to Figure 1, the present invention is intended to be used in association with conventional narrow gauge fibre optic cables 10, composed of an outer casing 12 and an inner core 16. The core is composed of multiple optical fibres 17 and a water blocking element 15. The core is preferably wrapped with a moisture barrier 14.

The cable contemplated for use in this invention has a small outside diameter (about 0.140 inches) which allows for easy placement into saw cuts made by common diamond blades. For cable installation within sidewalk joints and masonry surface walls, the cut should be less than about 0.1875 inches in width so that existing lines in sidewalks (joints and breakpoints) and grout lines between bricks can be followed without defacing the appearance and integrity of the infrastructure. As well, a small diameter cable allows installation under existing surface mounted conduits by elevating the conduit off of its underlying surface with a spacer block between the conduit and the surface. This spacer block will shift the conduit slightly (without disruption) following which the fibre cable can be pushed under the conduit and permanently mounted, as will be described in more detail below.

It is important that the cable remain reasonably straight when it is removed from the spool for installation into a crack or cut into a surface, so that it will lie flat in the bottom of the cable channel. If the cable has fixed bends from handling or from memory of being on the spool, it will rise out of the channel or cut in certain spots, making installation a challenge. To minimize fixed bends or memory of being spooled, the material used in the casing of the cable should be polycarbonate and the cable spool diameter should be sufficiently large to prevent memory (for example a 30 inch diameter core on the spools). A polycarbonate material does not distort easily; it springs back into its original shape after being handled (unless it is kinked with significant force). The polycarbonate material also exhibits a full range of good physical, chemical, and economical properties making it suitable for the present invention.

Turning to Figures 2(a) and 2(b), a typical node installation 20 is shown. A narrow slit-like trench or channel 30 is excavated into a paved roadway 22. The channel 30 may be cut into any type of paved surface such as concrete or asphalt, or into the interstices between courses of paving blocks. The dimensions and mode of excavation will be described in greater detail below. At the node 20, the trench depth and width is increased in order to accommodate a junction box 32 and accompanying cable loop 34. Within the trench leading up to and leading away from the node, the cable is installed in a conventional manner within the trench, such that it lies on the floor of the trench. At the node 20, the cable is looped into one or more loops 34 to provide slack for cable manipulation. The incoming cable includes a cable end 36, which enters a first side of the junction box 32. Within the junction box, the incoming cable end 36 is joined with a plurality of outgoing cables 38. For example, an incoming cable having twelve optic fibres may be mated with two outgoing cables having two and ten fibres respectively. A portion of the outer casing of the cable is removed to expose the optical fibres in the region of cable which will be fitted into the junction box. A selection of the exposed fibres 37 may be severed and respliced to optical fibres from a cable branch. Alternatively a passive optical component can be spliced in to form a branch

with another cable. The outgoing cables may all be laid within a common outgoing trench. Alternatively, a plurality of outgoing trenches may be provided in different directions heading away from the node where it is desired to form a network branch. If the outgoing plurality of cables are laid within a common outgoing trench, a branch may be provided at another location, as seen at Figure 2(b).

Figure 3 illustrates a non-junction node 40 of the network, which provides a looped portion of cable 34 to provide cable slack to accommodate future system expansion. At this node, the trench 42 is deepened, and one or more cabled loops are buried within the trench at this location. Figure 4 illustrates the cable loops prior to burial, and Figure 3 illustrates such cables subsequent to burial. At these nodes, a junction box 32 may be installed in the future. For this purpose, cable slack may be utilized from the node to permit such future installation.

Turning to Figure 5(a), a plan view of a trench 30 cut into a surface is shown, at a branching node position. It will be seen that the trench has a relatively narrow width at the locations 44 adjacent to the node, in the order of about 4 millimetres. At the node, the width 46 is increased, to about 12 millimetres. Conveniently, the slit-like trench may be cut into a surface by means of a saw. At the node, the depth of the trench is also increased. At positions adjacent to the node, the depth is in the order of 16 millimetres, while at the node the trench depth is in the order of 130 millimetres in order to accommodate the cable loops and junction box. However, even at its deepest the trench is wholly within the surface region of an asphalt or concrete roadway or sidewalk. If the trench is within a masonry or sidewalk joint, it is near the surface thereof for convenient installation and subsequent uncovering. Conveniently, the trench may be formed by in two steps. In a first step, a narrow saw cut is made along the full length of the cable line. In a second step, at each node a second saw cut is made with a second, wider blade to cut a slightly wider and somewhat deeper trench 46 at the node position, to

form a node-region having the shape shown in Figures 5(a) and 5(b). The trench 46 may be formed with one blade on a slab saw such as an 18 inch diamond blade with a width of about 4mm. The blade is dropped down 5" for the first pass, followed by a parallel cut in a slightly offset angle. The material between the cuts breaks away to form the required junction box cut.

As seen in Figure 5B, a rectangular junction box 32 may be installed within the node region 46 of the trench 30 such that it is fully enclosed within the trench. A metal plate 51 may be placed over the box 32 for subsequent localization by a metal detector, to aid in localization of the junction box in the future.

As seen in Figures 6 and 7, a similar channel 50 may be cut or formed horizontally within a wall 52. Figures 6 and 7 illustrate a masonry wall construction although it will be readily seen that other types of wall or wall surfaces also easily accommodate a similar cut. In Figures 6 and 7, it is shown to provide a channel having a similar dimension to that shown in Figure 5 within the inter-brick mortar 54 between courses of brick or other masonry blocks. Following installation of the fibre optic cables and nodes, the channel may be covered with additional (mortar or anchoring cement) This may be a semirigid grout material like polyurethane 56, to cover the channel. In one version, visual indicators 58 are provided to indicate the location of the channel for future work and to provide a warning to building owners as to the location of the cable. Such visual indicators may take any convenient form including a decorative arrangement.

Figure 7(a) shows an installation option similar to that in Figures 6 and 7, however, the channel 30 is cut vertically into the interstices between paving blocks 59 within a roadway or walkway. Ths steps are otherwise the same as described in connection with Figures 6 and 7.

Figures 8 and 9 illustrate additional installation options. In Figure 8, a slit-like channel 30 is cut vertically into an asphalt or concrete surface 62 such as a

road or a sidewalk. A plurality of cables 10 are installed within the channel in overlying relationship. For example, a convenient assay is up to four cables in a stacked overlying relationship within the channel. The channel is then patched with liquid rubber semi-rigid grout material such as polyurethane or anchoring cement 64 to provide a generally flush appearance. Figure 9 shows a similar arrangement, in which the channel 30 is cut into an expansion joint between a sidewalk 66 and an adjoining curb 68. Figure 9 also shows a similar channel 30 within a paved roadway 22 at a location close to the curb.

Figure 10 shows a close up view of an installation of the type shown in Figures 8 and 9, with a plurality of cables 10 installed within a trench 30 in stacked overlying relationship.

A locator wire 67 is positioned to overlie the cables 10. The wire 67 is locatable by a metal detector and permits early localization of the buried cables. Also, overlying the cables 10 is a rigid backing rod 69, for preventing the grout materials from sticking to the cables.

The trench is then patched with a convenient patch material 64 to provide a smooth appearance. Figures 11 and 12 show a similar arrangement with one or more cables 10 are installed within a narrow trench or channel 30 recessed into a sidewalk joint 66. The channel may be either vertical or horizontal.

Figures 11 and 12 illustrate a vertical channel or trench 30 having vertical sidewalls 68. The cables are overlaid with a sturdy wire 70, the purpose of which is to aid in future removal of the patch material 64. When it is desired to remove the patch material at a future date for maintenance or system expansion, all that is required is to excavate a portion of the channel to reach the wire. The wire 70 may be then pulled upwardly to remove the patch material from as much of the channel as is desired. The wire is formed from a corrosion-resistant and sturdy material, such as braided cable or any other convenient and suitable wire or cable arrangement.

The purpose of providing a plurality of cables in stacked array within the same trench is to facilitate splits and routes and to increase the fibre count delivered to an area. This feature makes it possible to cover a broader area and lessens the number of road or sidewalk cuts required.

Turning to Figures 13 and 14, a junction box 32 according to the present invention is illustrated. The box is generally rectangular in plan and elevational views, and is generally flat and plate-like in appearance. The box comprises a flat base 80, with a flat lid 82 removably joined to the base by screws or other like fastening means. A cavity 84 within the box is provided to receive cables, as will be described below. Opposed end walls 86 of the box are provided with a series of orifices 88A and 88B. At a first end of the box, one or more entry orifices 88A enter the box, to receive incoming cable. A sealant member 90 is provided at the openings to prevent or minimize moisture entry. On the opposed end of the box, a plurality of similar apertures 88B are provided for the outlet cables. The interior of the box provides sufficient space for a junction to be formed between one or more inlet cables, and a plurality of outlet cables. The junctions are formed by conventional means and are not shown. A gasket or other seal 92 between the base and lid provides a barrier for entry of moisture into the interior of the box. The interior of the box also provides sufficient space to house optical networking components such as splitters.

The box has a width of no more than about 12mm, in order to fit within the node region 20 of the trench or channel described above. Conveniently, the height and length of the junction box are about 95 by 190 mm. In another verison, the height and length are 65 mm long by 250 mm respectively.

In a further aspect, as seen in Figures 15(a) and 15(b), a cable 10 is installed underneath an existing surface mounted (i.e. above ground) conduit 100. This embodiment relies on a conventional conduit of the type which is supported on a surface 22 for example a cable-containing conduit supported by a paved

surface such as may be found in industrial settings. Similarly, a conduit may be surface-mounted against a wall. A small space is created beneath the conduit by separating the conduit from the surface. This is accomplished by inserting under the conduit a series of spacer blocks 102. It is contemplated that these will be about 0.1875 inches in thickness. Within the space thus created, one or more cables 10 are inserted and then installed with cement or the like. Junction boxes 30 as described above may be similarly mounted, as well as cable loops 34 being formed at nodes

CLAIMS:

1. A method for installing a subsurface fibre optic cable system within a substrate comprising the steps of:

   (a) cutting within said substrate a channel open to the surface of substrate having a width of between about 2mm and 12mm and a depth of between about 12mm and 172mm;

   (b) installing a fibre optic cable comprising multiple fibre optics strands within said channel;

   (c) providing at selected locations within said channel one or more junction boxes for said cable, said box having a width and height suitable for installation within said channel, said junction box having an interior space for holding a portion of one or more of said cables;

   (d) forming a branch or slice of individual optic fibres of said cable at a selected location;

   (e) enclosing said slice or branching region within the interior space of said junction box and sealing said junction box;

   (f) installing said cable and junction box together within said channel; and

   (g) sealing said cable and said junction box wholly within said channel to restore said surface.

2. A method as described in claim 1, comprising a branch of said cable, said cable having an outer casing, wherein the step of forming said

branch comprises removing said outer casing at the region of said branch to expose said optic fibres at said branch, and forming a loop of said fibres at said branch for provision of slack within said fibres, and sealing said looped portion of said fibres within the interior of said junction box.

3. A method as claimed in claim 1, comprising the further step of splicing into one or more of said fibres within said junction box a passive optical component.

4. A method as defined in claim 1, wherein said channel is formed within the interstices between pavers on a walkway or roadway.

5. A method as defined in claim 1, wherein said channel is formed within the interstices between bricks or masonry blocks within a masonry wall, said channel having a generally horizontal orientation.

6. A method as defined in claim 1, wherein a metal implant is buried within said channel at said junction box, to permit localization of said junction box after covering of said channel by a metal locating device.

7. A method as defined in claim 1, wherein visual indicators are provided within said channel visible after said channel is covered.

8. A method as defined in claim 1, wherein said there is further provided a generally continuous metal strip within said channel for localization of said channel following the covering of said channel.

9. A method as defined in claim 1, wherein a plurality of cables are installed in overlying relationship within said channel.

10. A method as defined in claim 1, wherein said channel is cut at a junction between a roadway and a curb.

11. A method as defined in claim 1, wherein said channels and junction boxes are arranged to form a branching and network of cables.

12. A method as defined in claim 1, comprising the further step of forming one or more loops of cable surrounding said junction box prior to burial of said cable in junction box within said channel.

13. A method as defined in claim 1, comprising the further step of providing one or more cable loops within said channel at a position removed from said junction box.

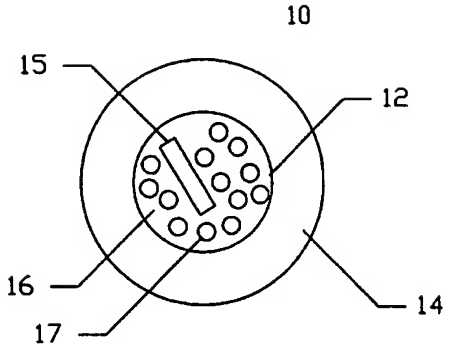

Fig. 1

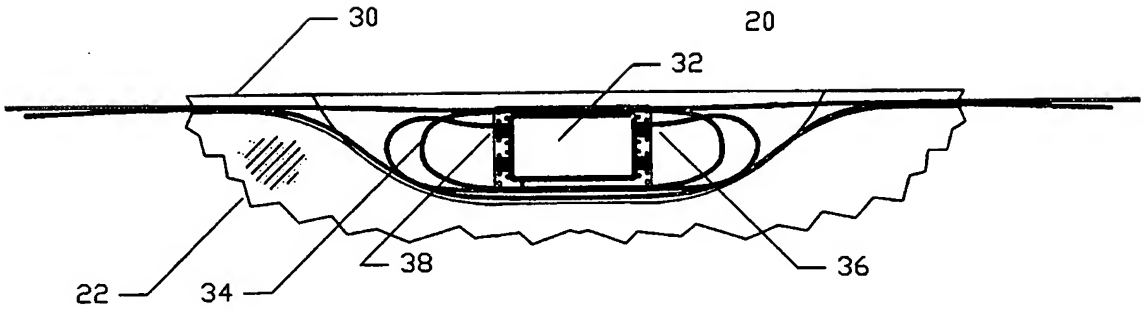

Fig. 2(a)

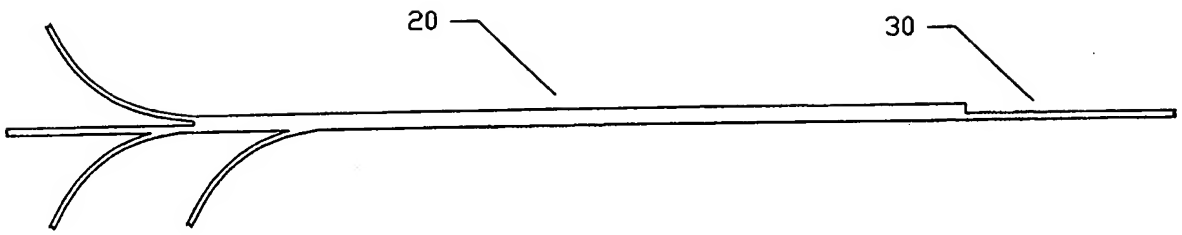

Fig. 2(b)

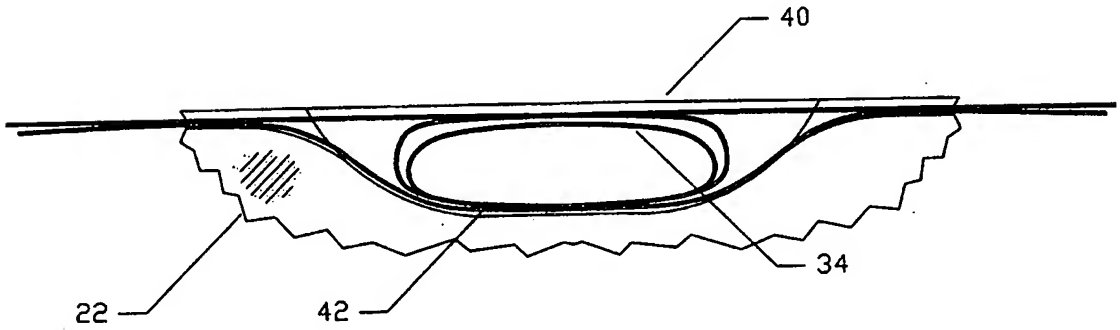

Fig. 3

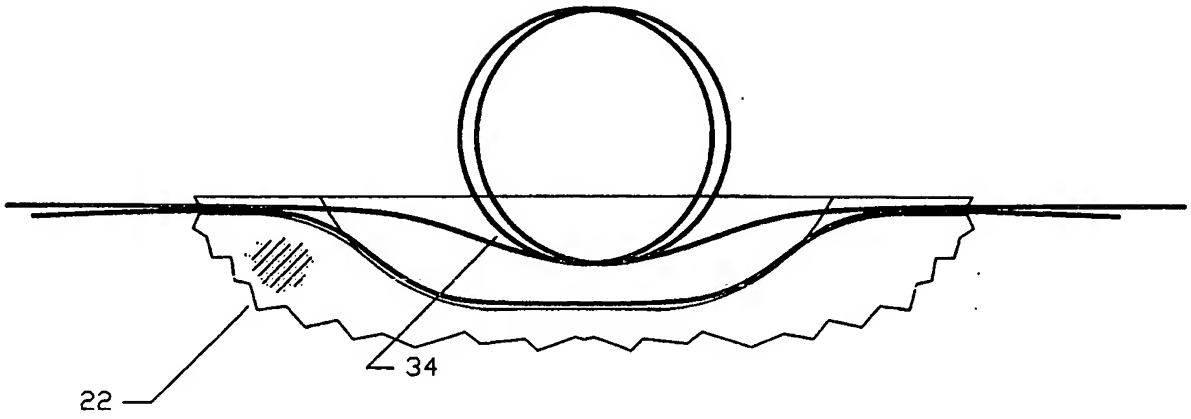

Fig. 4

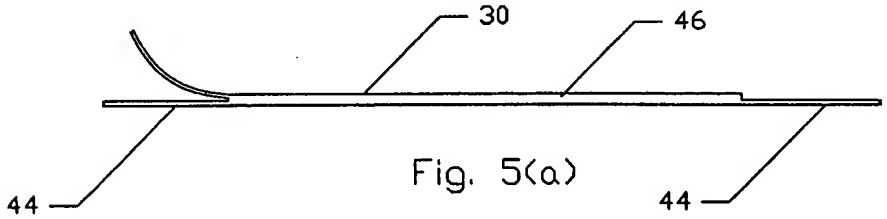

Fig. 5(a)

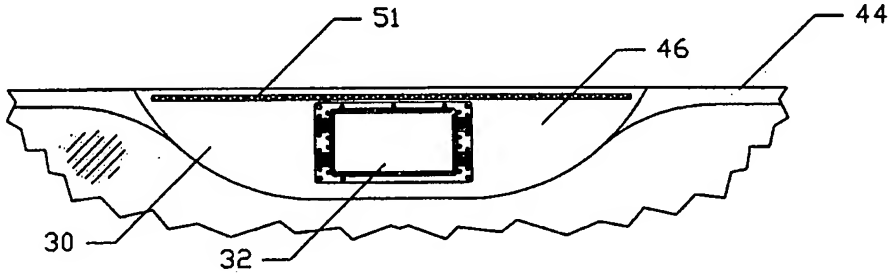

Fig. 5(b)

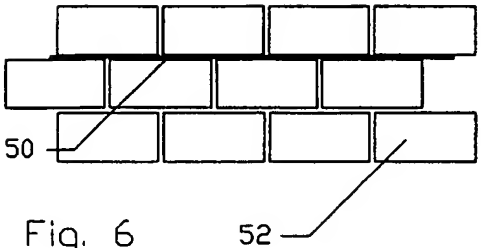

Fig. 6

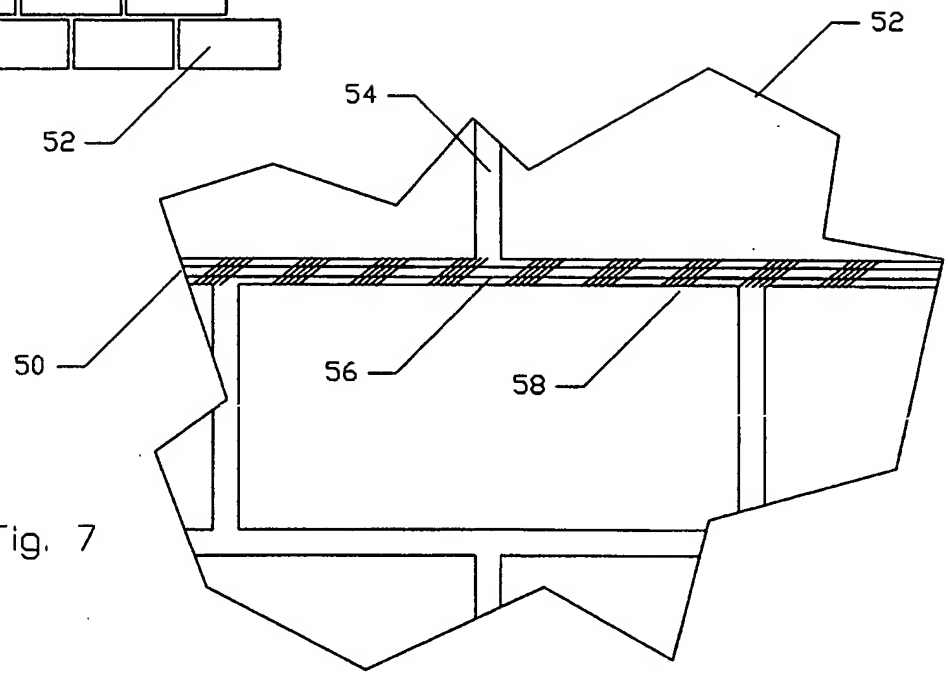

Fig. 7

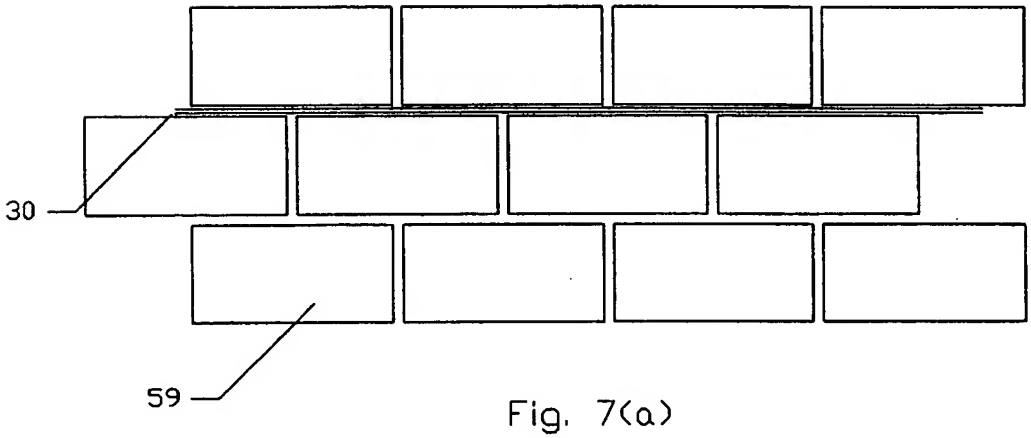

Fig. 7(a)

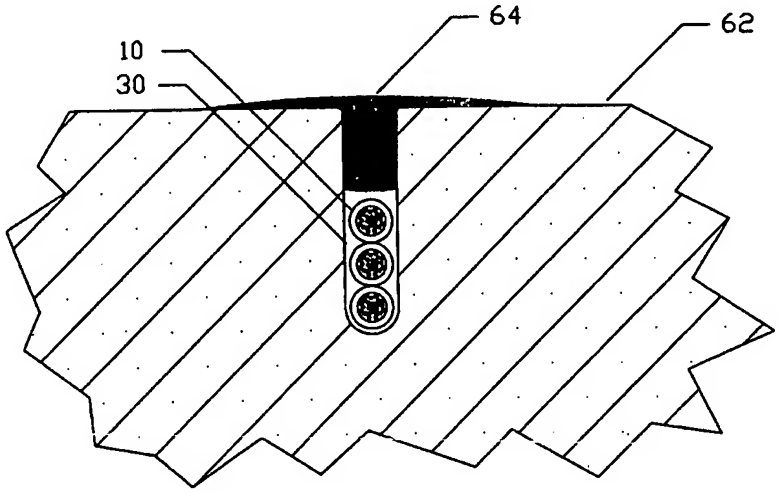

Fig. 8

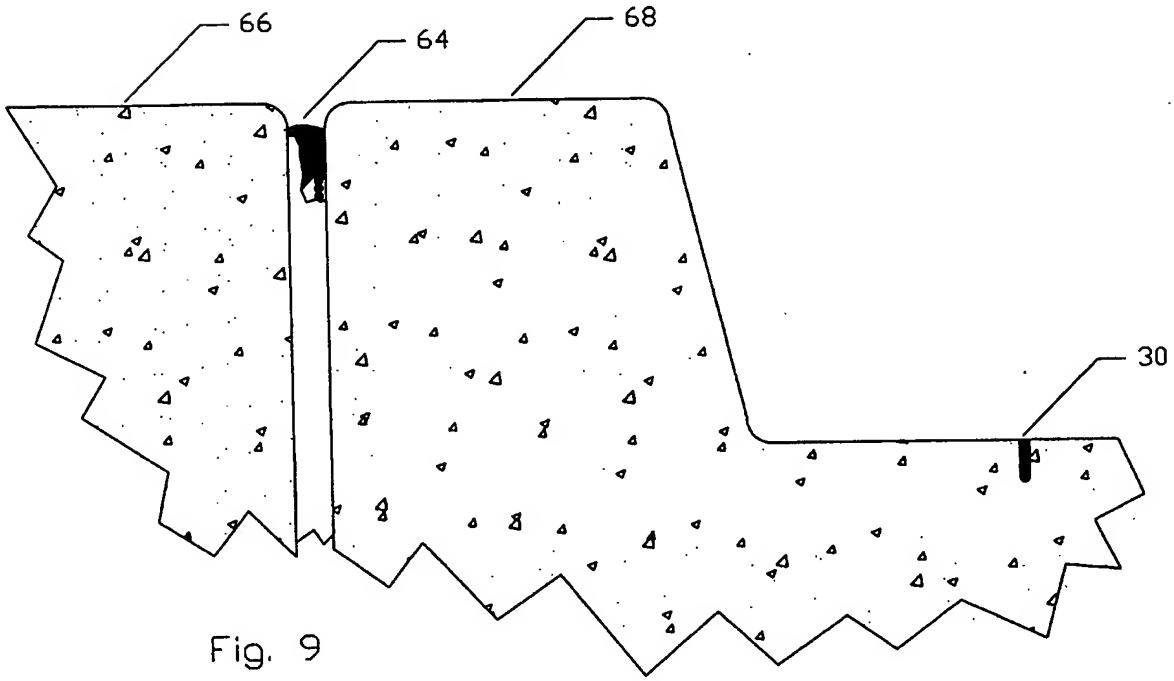

Fig. 9

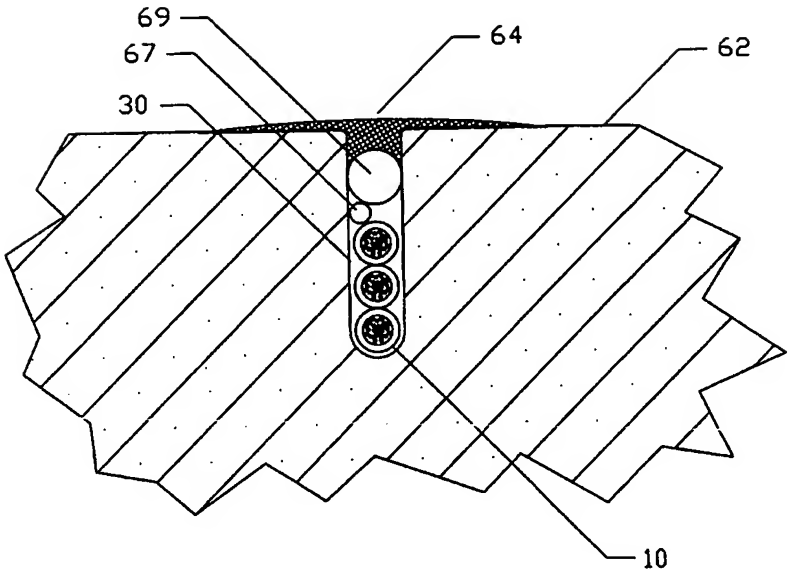

Fig. 10

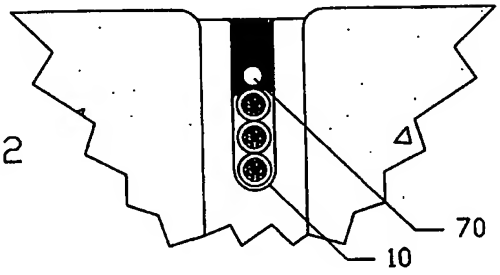

Fig. 12

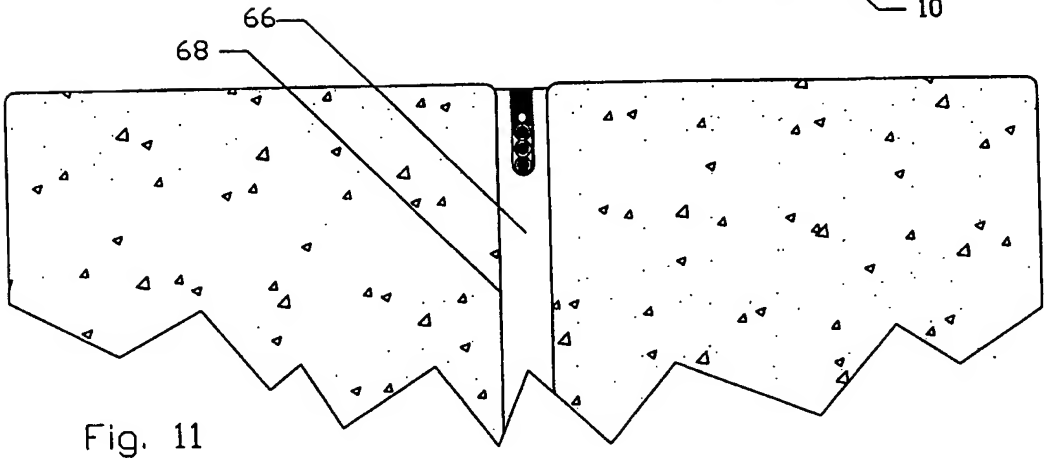

Fig. 11

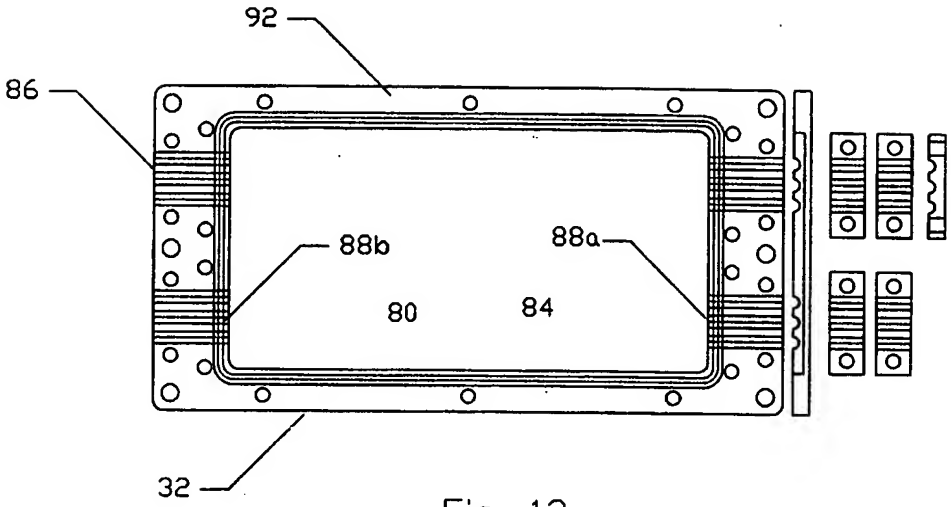

Fig. 13

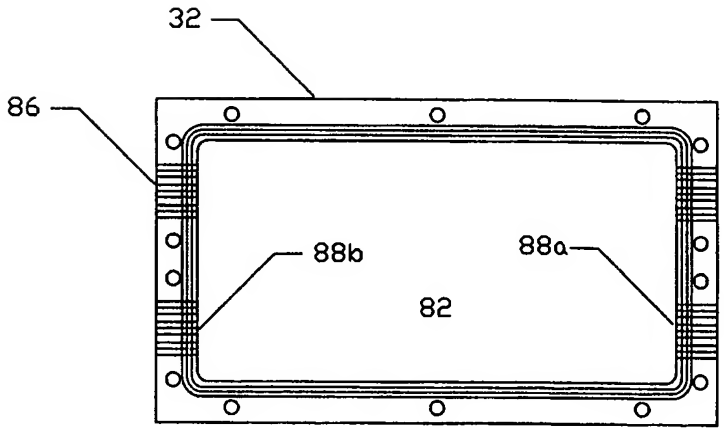

Fig. 14

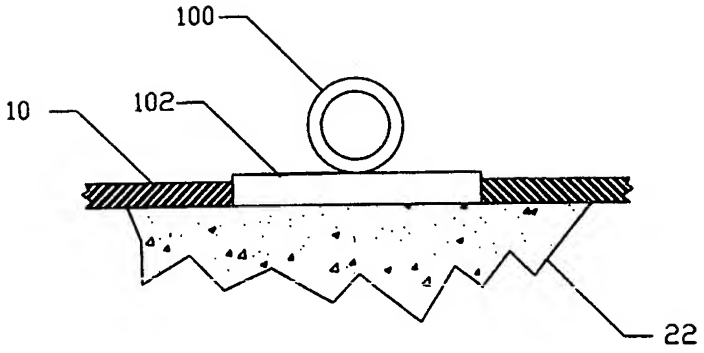

Fig. 15(a)

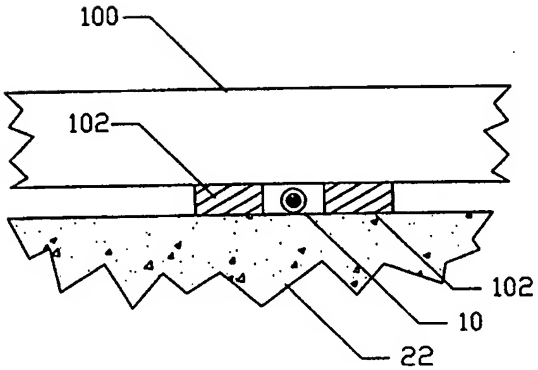

Fig. 15(b)